USDA Forest Service Forest Technical Assistance Trip

Agroforestry and forest restoration, Paraguay

US Forest Service Support to USAID Environment Program in Paraguay

Trip Report

Mission Dates: March 7 – March 21, 2008

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TABLE OF CONTENTS

Mission Itinerary 3
Map of Paraguay, with field trip locations 5
Map of Parque Nacional San Rafael and Libertad del Sur project area 6
Executive Summary 7
Scope of the Technical Assistance 7
Background
Objectives
Activities
Findings 12
Recommendations 14

Appendices
1. Original scope of work (communication from Guyra Paraguay to USFS-IP) 16
2. Field notes 18
3. Program for agroforestry workshop at the National University of Asunción 29
4. Survival and growth rates of planted native seedlings 30
5. pdf files of Safford presentations given March 18 at the workshop (attached) 31
6. Specific recommendations for nursery and seedling-propagation management 31
7. Specific notes and recommendations on tree planting 33
8. Specific recommendations on optimization of agroforestry systems in the Libertad del Sur project area 37
9. Photos 39

MISSION ITINERARY FOR USFS TEAM
March 7 – March 21, 2009

Saturday, March 7 – Sunday, March 8
- International travel days

Monday, March 9
- AM: Meetings with USAID and Guyra Paraguay
- PM: Meetings with Guyra Paraguay and Peace Corps; Safford arrival

Tuesday, March 10
- AM: Departure for San Rafael project area
- PM: Arrival at Parque Nacional San Rafael; visit to Guyrareta area of campos and forest islands; evening meeting with Guyra Paraguay staff and presentation on local fire fighting efforts

Wednesday, March 11
- AM: Attended workshop in Caronay with Guyra Paraguay staff, local farmers, and PROCOSARA, a local NGO
- PM: Visited local farmer's chacara to see agroforestry results, traveled to Bella Vista to visit hierba mate intercropping with pines and native trees

Thursday, March 12
- AM: Made visits to three farmers to see agroforestry successes and possibilities; visited local Peace Corp volunteer's nursery and agriculture library
- PM: Visited PROCOSARA farm and forest site; evening discussion with Guyra staff about PN San Rafael

Friday, March 13
- AM: Visited Guyra Paraguay properties near the Puesto Administrativo; inspected reforestation efforts along the Jacu Poi trail; sampled soils in forest and neighboring grassland
- PM: Visited Guyrareta area again to inspect reforestation efforts and to sample soils; visit to tree nursery in Amistad area

Saturday, March 14
- AM: Departure from PN San Rafael; visit to tree nursery in Alto Verá
- PM: Arrival in Encarnación

Sunday, March 15
- AM: Departure for Asunción
- PM: Arrival in Asunción

Monday, March 16
- AM: preparation for workshop
- PM: preparation for workshop

Tuesday, March 17
- AM: Part 1, Workshop at Universidad Nacional de Asunción: "Experiences with agroforestry in rural communities in Latin America"
- PM: Experimental design workshop at UNA

Wednesday, March 18
- AM: Part 2, Workshop at Universidad Nacional de Asunción: "Experiences with agroforestry in rural communities in Latin America"

- PM: Visits to UNA library, and faculty in the forestry, pathology, and soils faculties; briefing meeting with Guyra Paraguay staff

Thursday, March 19

- AM: Field day with Guyra Paraguay staff around Asunción
- PM: Office work

Friday, March

- AM: Briefing meetings with USAID staff, Asunción
- PM: Safford departure for the United States

Saturday, March 21 – Sunday, March 22

- AM: Cannon departure for the United States

Figure 1. Map of Paraguay with travel route. Map from geology.com/world/paraguay-satellite-image.shtml

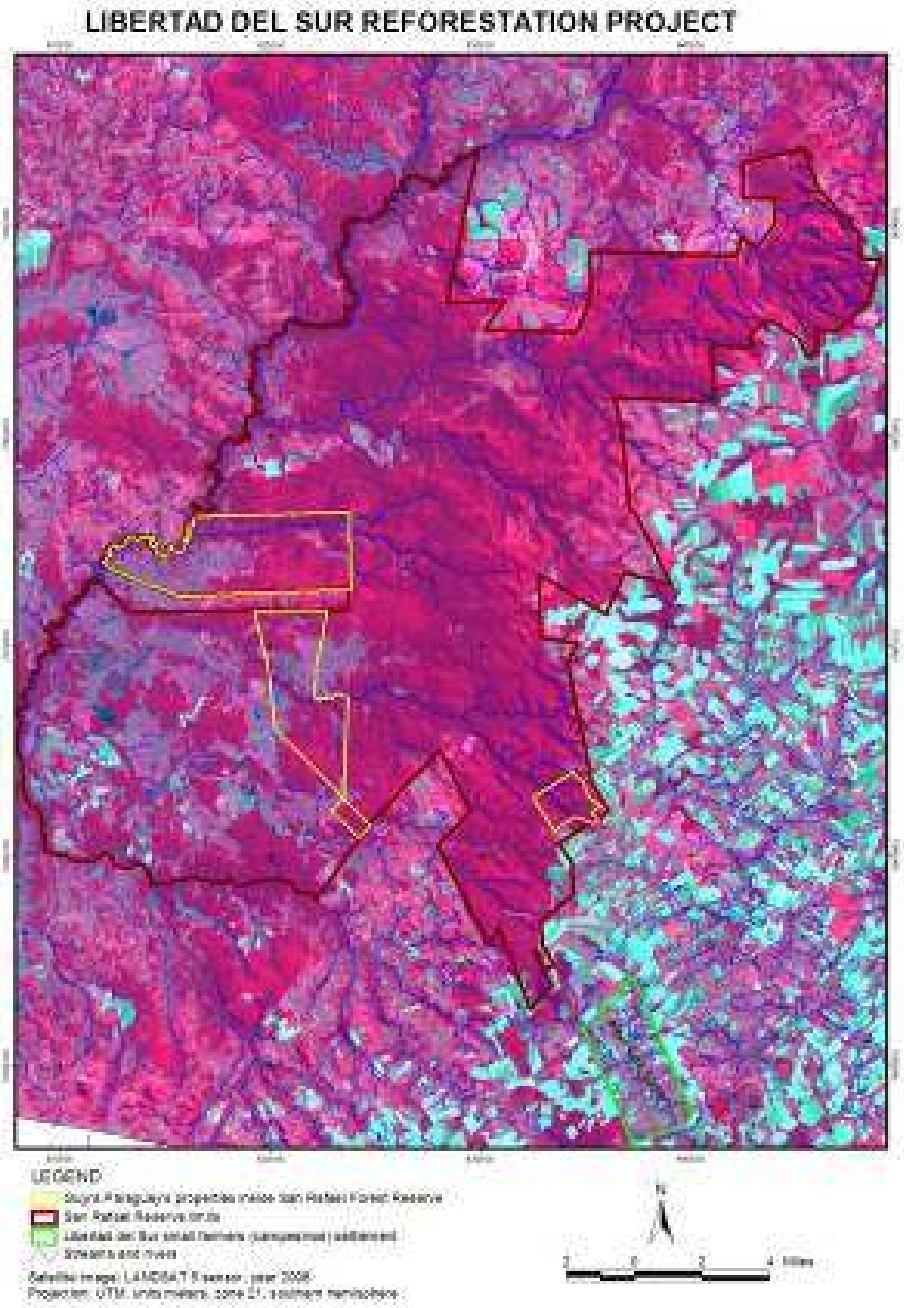

Figure 2. Parque Nacional San Rafael, and Libertad del Sur project area. Park boundary in black, Guyra Paraguay holdings are the yellow polygons. The rest of the park area is in private hands (ca. 55 landholders). The agroforestry project is focused on the area south of the Park. The large blue polygons to the east of the park area are primarily industrial soy farms.

EXECUTIVE SUMMARY

Hugh Safford (ecologist, Pacific Southwest Region), and Phil Cannon (plant pathologist, Pacific Southwest Region) participated in a two-week mission to Paraguay to conduct a technical assistance trip covering various aspects of the Libertad del Sur (LDS) reforestation and agroforestry project in southern Paraguay. The LDS project is being carried out by Guyra Paraguay, a non-governmental organization dedicated to the protection and sustainable management of biodiversity in Paraguay, with financial and technical support from USAID, among other supporting agencies. Guyra Paraguay sought Forest Service assistance to carry out a technical review of work already completed in the LDS project; to provide recommendations as to best practices for tree seedling propagation, planting, and management; and to provide recommendations vis-à-vis monitoring protocols and focus areas. The Forest Service team worked closely with a number of Guyra Paraguay staff, as well as faculty from the National University of Asunción. The team spent approximately one week in the field, visiting the LDS project area and the Reserva San Rafael, and one week in Asunción, conducting meetings and interviews and a two-day workshop on forest conservation, tree planting, and agroforestry at the National University. Our principal findings can be summarized in five points: (1) Guyra Paraguay (and its partners at other NGOs and the National University) has made impressive progress in forest conservation in southeastern Paraguay, and is expanding its area of interest to agroforestry support of local farmers; (2) reforestation efforts within the Reserva San Rafael have had moderate success, and we find that closer attention to soil conditions, and improvements in tree nursery management and tree planting techniques would better ensure the success of this part of the project; (3) general agroforestry capability of the small farmer community involved in the LDS project appears to be quite high, but optimization of agroforestry methods and planting mixes will require further engagement on the part of Guyra Paraguay and the National University; (4) Guyra Paraguay should focus monitoring efforts in the agroforestry side of the LDS project on socio-economic factors; (5) the small scale of the LDS project, and uncertainties tied to its ultimate success, suggest that original assumptions about its contribution to forest corridor development may be unduly optimistic, however the potential socio-economic benefits to local farmers are another important facet of the project. Our report includes many pages of recommendations tied to these findings.

SCOPE OF THE TECHNICAL ASSISTANCE

Background

The USFS team included the following individuals:

- Hugh Safford, USFS Pacific Southwest Region, Regional Ecologist.
- Phil Cannon, USFS Pacific Southwest Region, Regional Pathologist

Other individuals joining the USFS team in the field included:

- Marcelo Arévalos, Economist, Guyra Paraguay
- Ximena Silva, Forester, Guyra Paraguay
- Leticia Lopez, Ornithologist, Guyra Paraguay

- Oscar Rodas, Landscape Program Coordinator, Guyra Paraguay
- Elizabeth Monges, Forestry and Ag-Economics Professor, Universidad Nacional de Asunción
- Carlos Irrazabal, Ecology Professor, Universidad Nacional de Asunción
- Nick Rogers, Peace Corp Volunteer, Libertad del Sur, Paraguay
- Andrea von der Ohe, USFS International Programs, South America Program
- Various local contacts

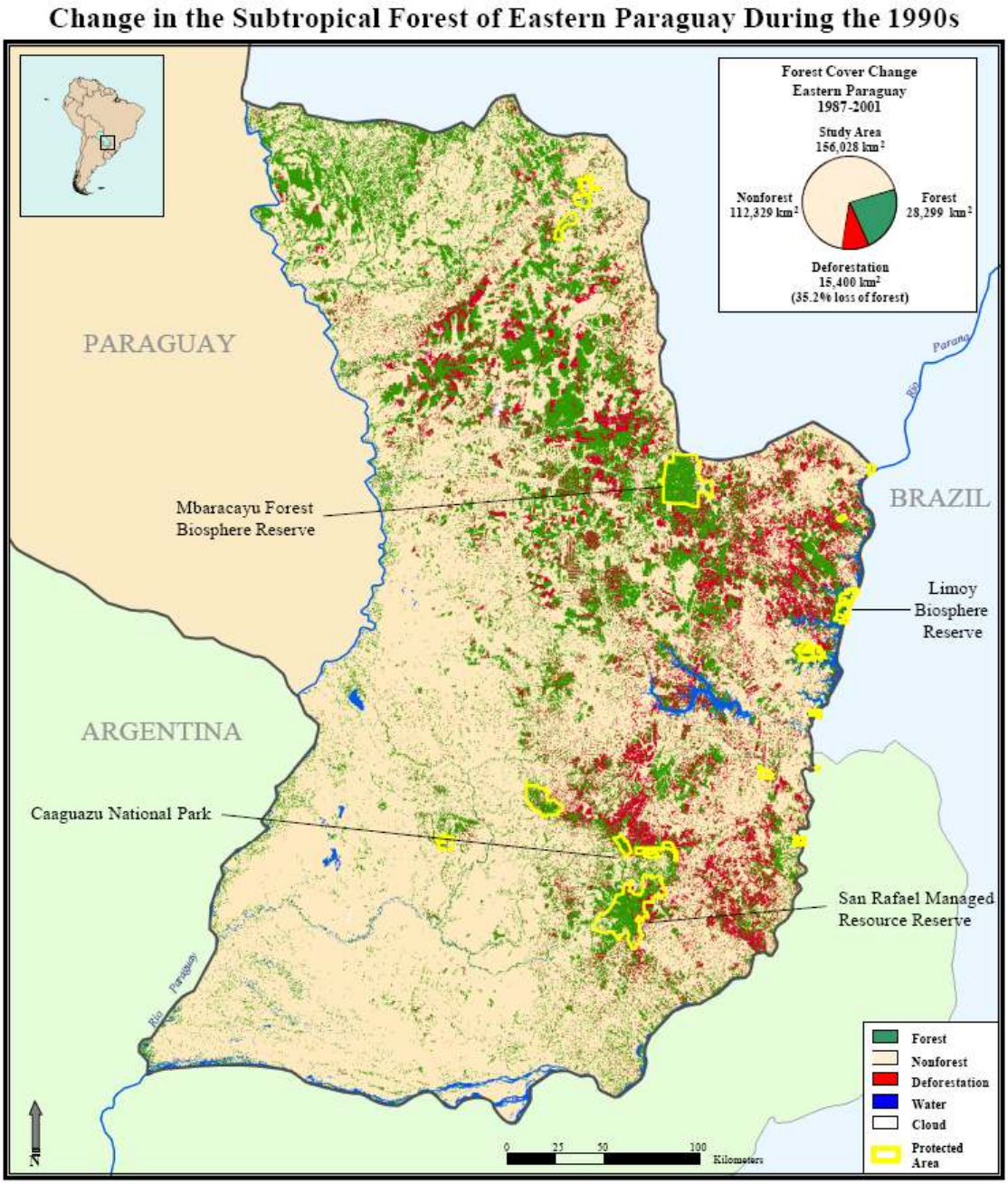

Figure 3. Deforestation in Paraguay between 1987 and 2001. Source: Global Land Cover Facility, URL: http://glcf.umd.edu

The area of the Reserva San Rafael is one of the last significant patches of more or less intact forest in Paraguay (Figs. 1-3). Paraguay has lost about 6/7 of its area of Atlantic Forest, a huge portion of that loss occurring between 1987 and 2001 (Fig. 3). The San Rafael area is of extreme conservation importance, and was one of the first *Important Bird Areas* (a BirdLife International designation) officially identified in South America. A 70,000 ha area of the Cordillera San Rafael was designated a National Park after the Rio de Janeiro environmental summit in 1992, but it remains a park on paper only, with about 55 different private landholders (Fig. 2). Over the last five years, Guyra Paraguay has been extremely active in the San Rafael region, purchasing over 6000 ha of forestland outright, forging partnerships with other NGOs to protect other areas, and most recently expanding its interests to include agroforestry support of small farmers in the fragmented lands surrounding the "National Park" (which we refer to as the "Reserva San Rafael" throughout this report). The original purpose of this shift in direction was a recognition that forest corridors simply could not be "built" in Paraguay without engagement of the landowners surrounding the few remaining forest patches. Guyra Paraguay's interest in the Libertad del Sur project thus has a major biological component, i.e. a regional increase in the cover of trees, but their interest in agroforestry as a conservation tool has developed beyond the initial focus on landscape-level patterns in forest cover to include a strong interest in sustainable development of ecologically-sensitive economic opportunities for small farmers.

The Libertad del Sur project has been developed with the support of a number of partner organizations, including American Forests, which provided funds to purchase and propagate 70,000 seedlings of (mostly native) trees, and the Paraguayan corporation Pajarito, which produces hierba mate products, and the US agency for International Development (USAID). Pajarito will provide credit to small farmers to buy mate seedlings, and in turn the farmers will enter into contracts with Pajarito that require organic farming practices. Finally, Pajarito will guarantee a market for the mate, at comparatively high prices, which result from the strong European demand for organic mate. Guyra Paraguay facilitated the involvement of Pajarito, and is working with the farmers to help them develop sustainable agroforestry practices that will meet multiple conservation and socio-economic goals.

Objectives and Approach

As stated in our Scope of Work (Appendix 1), the overall goal of the Forest Service mission was to conduct a technical assistance trip covering various aspects of the Libertad del Sur reforestation project in southern Paraguay, to carry out a workshop at the Universidad Nacional concerning reforestation techniques (among other things), and to consult directly with Guyra Paraguay and USAID-Paraguay. Summarizing Appendix 1, specific objectives were to:

1. Conduct a field review of Guyra's previous reforestation and agroforestry efforts in the San Rafael area.

2. Provide technical information on techniques (planting, irrigation, soil amendment, etc.) that might improve success and sustainability of reforestation and agroforestry efforts in the area.
3. Provide information on lessons learned from reforestation and agroforestry efforts in other parts of Latin America
4. Conduct a workshop for Guyra Paraguay staff and Universidad Nacional staff and students concerning our preliminary findings from the review and a set of other requested topics.
5. Provide recommendations regarding monitoring protocols and focus areas.

The team's approach was to (1) meet with Guyra Paraguay and USAID-Paraguay to get important background information related to the mission; (2) carry out a field review of Guyra's previous and ongoing reforestation and agroforestry efforts in the San Rafael area; (3) conduct an agroforestry workshop for interested university, Guyra Paraguay, and government staff and students; and (4) summarize results of its trip in a report.

Activities

See Mission Itinerary (p. 3) for a timetable and outline of activities. See Appendix 2 for more detailed chronological notes.

Monday, March 9: We held three meetings in Asunción: (1) Cannon and Andrea von der Ohe held a 2 hour AM meeting with USAID (John Beed, Director; Fernando Balsevich, Economic Growth Officer; Gabriela Frutos, OFDA Coordinator) to explain the purpose of the USFS visit and to coordinate with USAID staff. (2) Cannon and von der Ohe had a three hour mid-day meeting with Guyra Paraguay staff to get background on the Libertad del Sur project and other Guyra efforts in and around the Reserva San Rafael. Attendants included: Alberto Yanosky, Director of Guyra Paraguay; Rodrigo Zarate, José Cartes, Marcelo Arévalos, Oscar (Nacho) Rodas, Leticia Lopez, Ximena Silva, Cristina Morales, and Elizabeth Carrera. (3) Cannon and von der Ohe held a one hour PM meeting with Holly Radiche, Director of the Peace Corps Environment Program. The purpose was to learn about Peace Corps activities in Paraguay and to learn whether there might be Peace Corps volunteers in the San Rafael area who could collaborate with the project. Safford's delayed flight arrived in the evening.

Tuesday, March 10: Travel day, Asunción to Reserva San Rafael, and activities at the Reserva after arrival. Our group included Cannon, Safford, and von der Ohe from the USFS; Oscar Rodas, Marcelo Arévalos, Ximena Silva, and Leticia Lopez of Guyra Paraguay; Elizabeth Monges and Carlos Irrazabal of the Universidad Nacional. We made two mission-related stops along the way: (1) we visited a ten-year-old loblolly pine plantation with a heavy undergrowth of native tree species; (2) we picked up Nick Rogers, a Peace Corps volunteer based in Libertad Del Sur (Rogers would stay with us for the rest of the week). After arrival at the Reserva headquarters at Kanguery, we visited a new section of natural forest that Guyra Paraguay (GP) had recently acquired, and then we visited the Guyrareta area, where GP had recently planted trees. The day was finished with an evening presentation by Daniel Espínola, local GP staff and head of the

local volunteer fire department, on fire fighting preparations in the area of the Reserva San Rafael.

Wednesday, March 11: We visited the farm of Victor Algarin in the morning, then attended a three hour workshop and lunch at the Caronay community center with approximately 20 small farmers (plus some of their families). The workshop was organized by Guyra Paraguay to introduce the Libertad del Sur project to a wider audience of local farmers. The USFS staff was also asked to speak, and we briefly outlined the roles we hoped to play in supporting the Libertad del Sur project. In the afternoon, we traveled to Bella Vista to review agroforestry activities in the area (hierba mate intercropped with overstory pines and native hardwoods). Andrea on der Ohe and most of the Asunción-based GP staff returned to Asunción at this point. On the return to Kanguery, we inspected some areas of soil erosion in large soy fields.

Thursday, March 12: In the morning we visited three separate small farmers (Jorge Villalba, Blas Amarillo, and Eugenio Perez) to inspect their agroforestry practices, and we viewed Nick Roger's (Peace Corp) teaching nursery and library in Libertad del Sur. In the afternoon we visited the large farm where PROCOSARA (Asociación Pro-Cordillera San Rafael) is based. PROCOSARA is a local NGO which supports organic farming, tree planting, and general conservation in the San Rafael area.

Friday, March 13: In the early morning, the remaining Asunción-based GP staff left for Asunción. Cannon, Safford and Daniel Espínola spent the morning in the secondary forest adjoining the Kanguery site. We hiked the trail that GP has constructed through the forest, inspected a 8-hectare clearing where GP had planted trees for reforestation and carried out an inventory of seedling survival, and compared soils within the forest and grassland immediately adjacent to the forest (Kanguery staff dug soils pits for us during our absence). In the afternoon, Cannon accompanied GP staff on a revisit of the Guyrareta plantations in order to dig soil pits and inventory seedling survival, and to visit the local nursery at La Amistad where seedlings are being held for the next planting at Guyrareta. Safford remained at Kanguery to consolidate notes and read and summarize GP literature on the Reserva San Rafael.

Saturday, March 14: In the early morning, we consolidated our field notes and observations; Cannon also collected a soil sample for chemical analysis and conducted a quick review of the small flying nursery at the Kanguery site. In the late morning we visited the large nursery in Caronay, where GP grows many of its seedlings. In the afternoon we traveled to Encarnación, and worked in the evening on our presentations for the Asunción workshop.

Sunday, March 15: Travel day, return to Asunción from Encarnación.

Monday, March 16: Preparation day for workshop.

Tuesday March 17: Day 1 of workshop, 0800 to 1700: "Experiences with forest plantations in rural communities in Latin America" (*Experiencias con plantaciones*

forestales en comunidades campesinas en Latinoamerica). See Appendix 3 for workshop program. USFS involvement: Safford, opening remarks; Cannon presentation: "Plantation and irrigation techniques, how to improve plantation results"; Cannon presentation: "Experiences in Central America and Peru in reforestation projects with rural communities"; Cannon mini-workshop: "How to design forestry experiments".

Wednesday, March 18: Day 2 of workshop, 0800 to 1300. USFS involvement: Safford presentation: "Monitoring protocols for agroforestry: experiences in Latin America"; Safford comments: Observations on landscape patterns of forest retention and agroforestry projects in the San Rafael area; Safford presentation: "Fire management: case studies from Latin America". After lunch, Cannon met with members of the Forest Pathology department and visited the University nursery (which Safford had visited the previous year). Safford visited the University library and began work on the trip report. In the late afternoon, Cannon and Safford met with Guyra Paraguay staff, and finished with an exit interview with Alberto Yanowsky (Director) and Ximena Silva.

Thursday, March 19: In the morning GP staff (Silvia Centrón and Alistair Kerlin) took Cannon and Safford on a field trip to a community across the Rio Paraguay. In the afternoon, we worked on the report and prepared for the USAID exit interview.

Friday, March 20: In the morning, Safford and Cannon held an exit interview with USAID (Mike Eschelman and Fernando Balsevich) at the Asunción office. During the late morning, we outlined the report and assigned writing tasks. Safford returned to the US at 1500, Cannon worked on his trip notes during the afternoon.

Saturday, March 21: Cannon returned to the US at 1500.

FINDINGS

See Appendix 2 for more detailed notes associated with specific days. Here we summarize our salient findings:

1. Guyra Paraguay (GP) is an impressive organization. GP has a strong track-record for innovative and successful involvement in conservation initiatives in Paraguay; it has an educated and energetic staff; it has institutional capacity far beyond most other conservation NGOs in Paraguay; and it has successfully worked with a long list of international support and donor organizations. To this point, Guyra Paraguay and the Fundación Moises Bertoni (the original parent of GP) are the two Paraguayan conservation NGOs one hears about outside of Paraguay.
2. GP's work in the San Rafael area is a new direction for them. We applaud GP's decision to move into agroforestry support as part of its general conservation mission. Conservation in fragmented habitats is impossible without direct engagement with the local populace, and GP has made important steps in this direction in the San Rafael area. There seems to be a high level of local support for the Libertad del Sur project, and the general agroforestry capability of the small farmer community in the area appears to be high.

3. Peace Corps-Paraguay could play a larger role in providing agroforestry support to forest conservation in southern and eastern Paraguay. We were very impressed with the efforts of the Peace Corps volunteer in Libertad del Sur (Nick Rogers), but support delivery was limited by his lack of mobility, and the fact that he was the only volunteer in this part of Paraguay.
4. GP has entered into a cooperative agreement with the Forestry faculty at the National University of Asunción that greatly expands GP's access to technical expertise in reforestation, commercial forest management, and landscape-level assessment of forest cover (among other things). This arrangement should also provide a source for focused studies, in the form of undergraduate and graduate theses. As part of the agreement, GP has promised to provide transport, room, board and other support to students and faculty with interest in working in the San Rafael area.
5. GP's primary focus in the Libertad del Sur project is planting trees, either in lands they own within the Reserva San Rafael itself, or on private properties surrounding the Reserve. We found that problems in tree nursery management and tree planting techniques pose threats to the success of the project. We also found that soils within the Reserve lands owned by GP are often very poor, and will require special effort to successfully reforest.
6. Most of the trees (50,000 of 70,000) being supplied by the American Forests, USAID, and US Forest Service funding are destined for small farmers. These will be supplied at a proportion of 60:40 native:exotic, with the farmers themselves making the ultimate decisions as to which species they want to plant. 120 families have been targeted by the LDS project, which equates to about 600 total people benefiting (at 5 people per family). If everything goes according to plan, GP hopes to increase small farmer family incomes by about 30%. The remaining 20,000 trees from American Forests are destined for reforestation efforts within the Reserva San Rafael. GP will employ members of the Amistad settlement to plant and tend these trees, and hopes to benefit 15 local families through this work.
7. As in most of tropical and subtropical Latin America, fire is a major impediment to forest conservation in the San Rafael area. Some of GP's local staff in San Rafael is trained in fire prevention and control, and they are also engaged in active efforts to train local citizens and to create and support local volunteer fire brigades. This is very important work, and it was wonderful to see the energy and commitment of GP's local fire staff. Although some grassland areas in the eastern part of the Reserva San Rafael are clearly "natural" (due to high water tables), many grassland areas in the reserve are the outcome of logging, grazing, and fire. Reforestation of these areas will require that they are protected from fire until tree cover can be reestablished.
8. As noted above, GP's decision to enter into agroforestry support in the areas surrounding the Reserva San Rafael is laudable, however the scale of the Libertad del Sur project is very small, and 70,000 seedlings (the current target) will not go far toward reestablishing meaningful tree cover on private lands. All good ideas start small, but any real progress in increasing forest cover outside of the Reserve itself will require high levels of investment and a great expansion in outreach. To

compare, The Nature Conservancy is funding the planting of one billion seedlings in similarly fragmented parts of the Atlantic Forest in Brazil. Of course, there are also other reasons to engage with small landowners, and GP's efforts in this realm have already realized diplomatic benefits with the locals and they have increased local support for GP's overarching goals in the region. Success of the Libertad del Sur project may also create an economic buffer that makes continued loss of land to large soy farms less likely.

9. Monitoring is very important, and GP appears to have a handle on biological monitoring for the Libertad del Sur project (among other projects), but we saw no evidence that socio-economic monitoring was underway or planned (other than Marcelo Arévalos' economic analysis of organic sesame production). It may simply be that we did not talk to the proper people at GP, but we must stress that Latin America is full of failed agroforestry projects that could not "pay for themselves". If the small producers cannot support themselves and their families as least as well as before the project, there is almost no chance that the project will succeed in the long run. The only way to determine if socio-economic goals are being met in the Libertad del Sur project is to continuously monitor a set of socio-economic indicators.
10. There is obvious tension between the small farmer communities outside of the Reserve and the large, industrial (mostly) soy farms that have taken over most of the landscape over the last couple of decades. We heard many tales of water and air poisoning from pesticide/herbicide/fungicide spraying on the large farms. The small farmers see the huge soy farms as far greater threats to forest conservation and wonder why they are not the focus of government and NGO efforts to enforce already extant conservation and environmental law.

RECOMMENDATIONS

1. The National University and GP (and other conservation organizations, both government and non-government) should work to fortify their alliance. GP has made a tremendous offer of field support to prospective student and faculty researchers, and there are a broad number of important thesis topics to be had. Thus far the Faculty of Forestry does not appear to have seriously entertained the notion of expanding its mission to include conservation forestry, but we recommend that the Faculty consider course- and thesis-work that could support such a move. The US-Forest Service could work as a partner in helping to develop curricula and thesis topics.
2. GP should institute a monitoring program in Libertad del Sur that deals specifically with socio-economic indicators of project success. Prof. Lisa Monges gave a presentation during the agroforestry workshop that showed that the Forestry Faculty has the know-how to conduct socio-economic monitoring of agroforestry projects. We believe that GP should work with Prof. Monges and others at the National University to develop a socio-economic monitoring program for the Libertad del Sur project. We also recommend that GP look closely at the experiences of other socio-economic monitoring programs in Latin

America. Literature references for some of these experiences were given by the USFS team during the agroforestry workshop, and are available in the presentation given by Safford on monitoring (a pdf version of this presentation is provided as an attachment). See also Recommendation 5 and Appendix 8.

3. Significant work will be required to bring nursery management practices up to standard in the Libertad del Sur project area. Again, we believe that close collaboration with the National University will pay large dividends. The Forestry Faculty nursery was the best managed nursery we saw in Paraguay, and in the short-term we recommend that GP contact the nursery manager to seek direct help. For the longer term, we recommend that the University and the US-Forest Service work together to develop a one- to two-week nursery development and management course. We have some specific recommendations regarding the finer points of nursery and seedling-propagation management. These are found in Appendix 6.
4. We found that tree-planting practices employed in reforestation efforts in the Reserva San Rafael required improvement. The US-Forest Service could send experts in the topic to help train a select group of in-country trainers, and the University and Forest Service could also work up a companion course to the nursery course mentioned above. We have many specific recommendations regarding tree planting. These are found in Appendix 7.
5. We recommend that GP, ideally in conjunction with the Forestry faculty at the National University, work closely with the small farmers in the Libertad del Sur project area in order to help them optimize the agroforestry systems they are using. It appears that most decisions about what to plant, how to plant, and in what combinations, are being made principally by the farmers themselves. There is a rich body of knowledge from elsewhere in Latin America that should be brought to bear in helping to inform these decisions. In addition, further research should be undertaken within Paraguay itself. Improved care of planted trees as they grow is also recommendable, for example through more informed use of thinning and pruning practices. We provide some specific agroforestry recommendations in Appendix 8.
6. The area of the Reserva San Rafael is one of the last significant patches of more or less intact forest in Paraguay. We believe that GP's decision to work closely with private landowners surrounding the reserve is a positive step toward conservation of forest habitat in the area and perhaps even reversal of forest loss. However, we also believe that meaningful protection of forest cover in the area is unlikely without redoubled efforts to purchase and legally protect those areas with extant forest cover. We also caution against assuming that small-scale agroforestry projects will have much of a positive impact on regional forest cover. We recommend that GP continue to focus its efforts on land purchases and/or conservation easements to safely and surely conserve extant forest blocks within the demarcated Reserva San Rafael.

APPENDIX 1: Scope of Work

Email communication from Alberto Yanosky to Andrea von der Ohe, January 8, 2009

Dear Andrea, thanks for our phone call from yesterday. Below you can see what we would like from the USFS experts, but primarily remember that I would first for them to evaluate what we have done and provide us with recommendations on what we are doing well and should improved, as well as those things that were done wrongly. This is an area we are expanding and we understand and are committed to expand our experience in habitat restoration, either by planting as well as allowing natural regeneration (sometimes with assistance with tree-planting.

Topics for technical assistance from USFS for the Libertad del Sur Reforestation Project

It is expected that the USFS will give technical assistance for the development of this project, for this Guyra Paraguay would be willing to receive capacity building and accompaniment in the following way:

1. Evaluation of previous experiences of Guyra Paraguay reforestation with native species and restoration projects in the Area of San Rafael
2. Planting techniques to help the producers to learn better ways to plant native species
3. Knowledge about irrigation techniques
4. Experience in other similar projects to the community and also to the teachers and students that will participate in the project
5. Technical support in sustainable development that could teach a new technique or approach on the already existing project of sustainable development
6. Monitoring protocols to the producers and the students
7. Landscape approach to integrate plantation of native trees in rural farms with the objective of build a biological corridor

Regarding the dates, workshops and initial visits mentioned above could be planned between February and March provided the American Forest and Scope of Work are duly approved. The evaluation of what has been done could be also performed during this visit. Planting could happen between March-April as some seedlings could be already purchased form the nurseries in the communities.

Please let us know if you have any doubt on this.
Alberto Yanosky

Original Draft Agenda February 13, 2009
USFS Experts Team
Visit to Paraguay (March 9 – 20, 2009)

March 9, Monday

Arrive to Airport,

Meetings in USAID.

March 10, Tuesday

Trip to San Rafael,
Includes: Nacho, Ximena, Leticia, USFS experts (Hugh Safford and Phil Cannon), Andrea von der Hohe and Marcelo
Teachers Lidia Perez de Molas, Elizabeth Monges and Carlos Irrazábal

March 11, Wednesday

Evaluation of the experience of Guyra Paraguay restoration project
Visit to Kanguery and Guyra Reta, Ocampos

March 12, Thursday

Trip to *Libertad del Sur*,
Meeting on *Libertad del Sur*, with the producers subjects to be discussed:

- Planting and irrigation techniques
- Experience in other similar projects to the community that will participate in the project
- Technical support in sustainable development: new techniques or approaches on the already existing project of sustainable development
- Monitoring protocols
- Environmental indicators of forest health
- Landscape approach to integrate plantation of native trees in rural farms with the objective of build a biological corridor
- Fire Management

Return to San Rafael

March 13, Friday

Libertad del Sur, visit to 2 or 3 ranches.
Bella Vista, visit to Agroforestry plots with Yerba Mate. Lunch and return to Asunción (1 truck). This truck includes Perez de Molas, Elizabeth Monges, Carlos Irrazábal, Andrea von der Ohe, Nacho or Marcelo.
The other truck goes to Mbatovi.

March 14 Saturday

Visit Mbatovi,

March 15, Sunday

Mbatovi. Return to Asuncion

March 16, Monday

Workshop on the Faculty of Agrarian Sciences, subjects to be discussed:

- Planting and irrigation techniques
- Experience in other similar projects to the community that will participate in the project

- Technical support in sustainable development: new techniques or approaches on the already existing project of sustainable development

March 17, Tuesday

Workshop on the Faculty of Agrarian Sciences, subjects to be discussed:

- Monitoring protocols
- Landscape approach to integrate plantation of native trees in rural farms with the objective of build a biological corridor
- Fire management

March 18, Wednesday

Workshop on the Faculty of Agrarian Sciences, subjects to be discussed:
To be discussed with the Faculty of Agrarian Sciences

March 19, Thursday

Meetings in Guyra Paraguay

March 20, Friday

Meetings in USAID

APPENDIX 2: Notes from meetings and field trips, arranged chronologically

Format: the first number is the date ("9" = March 9), the second number orders the notes.

Asunción meetings

9.1 There have been several recent personnel changes at USAID with the result that there are new people now in charge of this project. Fernando Balsevich is now in charge of USAID's support to several projects being executed by Guyra Paraguay. He indicated that he would be extremely interested to learn more about the Libertad del Sur project and to learn about USFS team findings following our review of the project.

9.2 Guyra Paraguay (GP) has an exceptionally strong and alert team of scientists, economists, and planners. This is a very impressive organization, and one of only a couple in all of Paraguay with more or less "first-world" capacity. GP has close connections with many international conservation and funding organizations, including US Fish and Wildlife Service, TNC, WWF, CI, etc. GP has an enormous amount of experience in avian and ecological studies, but they have recently expanded the areas of their interest to general landscape conservation and socio-economic support to agroforestry projects. The Libertad del Sur project is a new direction for them, and the USFS mission is meant to provide them a technical review of the project's progress thus far.

9.3 The Peace Corps strongly supports involvement of volunteers in projects such as GP's Libertad del Sur project. Peace Corps has made arrangements so that volunteers can apply some of their experience towards a Masters degree back in several stateside Universities. We were told that there was one volunteer in the San Rafael area (Nick Rogers), and he is working in agroforestry support in the Libertad el Sur area.

Trip from Asunción to Reserva San Rafael

10.1 Most of the land south of +/-Villa Florida on Highway 1 is in large, industrial agriculture, principally soy, but also corn, cane, sorghum, and sesame. It all looks incredibly like southwestern Brazil (perhaps not so incredibly). Some of the landscape is found on the flood basalts that poured out of southern Brazil in the Jurassic. These huge farms are a major threat to biodiversity and landscape conservation.

10.2 In the loblolly pine stand that was visited en route to the reserve it was seen that there was an enormous amount of naturally regenerating forest native tree species in the understory and, importantly, no pines seedlings or saplings. The pine was essentially acting as a nurse plant for native forest, and upon its removal, a secondary native forest could be the result. Although loblolly pine does not appear to be invading native forest at this site, it is classified as moderately invasive and is known to have invaded forest in other parts of Latin America. That said, loblolly is much safer to plant than Monterey pine (*Pinus radiata*), which is highly invasive.

Reserva San Rafael

10.3 GP owns about 6000 ha of the Reserva San Rafael area (70,000 ha), which exists on paper but has never been formally delimited and there are many dozens of land owners within the supposed boundaries. We were told that it would take maybe $20,000,000 to pay off the land owners, which the government doesn't have, and which has better uses (combating general poverty, e.g.) if it ever shows up. The Puesto Administrativo is on a grassy hill with floresta on the east side, and pradera on the others. This area was bought 5 years ago. It is a nice facility, and with the completion of the new lodge will be more than adequate for large visiting groups. Parts of the grasslands within the park area are natural (in wet bottomlands typically), but most of them are African grasses and were created by landclearing many years ago and livestock grazing since. This time of year, one can stand in an area and see the edge of the erstwhile forest, marked by the beginning of the bright green grass *Brachiaria*, which tends to run right around the lower border of areas of high ground.

10.4 We visited an area GP bought 6 years ago that has a few areas of relatively old forest. There were some huge *Peltophorum* in there, but as in most places the forest is very much secondary growth.

10.5 The native tree plantations at Guyrareta have had relatively poor success. A number of local farmers were hired to do the planting, and a small group of them is supposed to go out and grub the grass and weeds around the plantings. We told them they needed to clear the weeds three or four times a year at least. In the first location less than 5% of the trees were still alive one year after planting, in the second it was more like 15% due to higher soil moisture, but that is still poor success for one year. Very few of the surviving trees had actually grown at all since planting. It turned out that they had not removed the plastic bag from around the seedling's soil ball before planting. We found a number of cases where the roots had not made it out of the bag. Although the failure to remove seedlings from their bags certainly led to some mortality, the low success at this site is probably mostly due to the fact that no soil investigations appear to have been made before planting (the soils are very sandy, nutrient-poor, and seasonally flooded in some places). Such poor soils require significant site preparation and can be difficult to plant successfully even with site preparation.

10.6 In the evening we were treated to a presentation by Daniel Espínola, a local GP employee, who is also the driving force behind the local volunteer fire brigade. Daniel has a lot of energy and has overseen the training and equipping of many local farmers (and their wives!).

Visits to small farms in the Libertad del Sur area

11.1 Victor Algarin (who is also the vice-president of the local producer's committee, sort of a proto-cooperative) has many different agroforestry systems on his land. They involve several different combinations and different spacings with the following species:

Eucalyptus grandis
Sweet oranges
Pomelo
Sesame (organically grown)
Cedrela
Tabebuia
Paraiso
Loro Negro
Pinus taeda
Grevillia robusta

All of these species were growing well on the well-drained red Ultisols on Victor's farm, but there was no concept of what the best combination and spacing should be if Victor is to maximize the returns he realizes for his efforts and the land that he has tied up with these different species. Some of Victor's *Eucalyptus* had grown up to 10 meters in one year, which is fairly remarkable given the thin, rocky nature of the soils on his property.

11.2 Some of Victor's trees are reaching an age where pruning is an important activity to carry out to improve wood quality. (Note: in most agroforestry systems, there is considerable space between neighboring trees and this can lead to trees forming large branches throughout the crown. Timely pruning is relatively simple to improve this situation but there is a way to prune trees that leads to substantially better development of high-quality logs than any other approach, see Appendix 8.)

Workshop for small farmers in the Libertad del Sur project area

11.3 About 40 people, including about 12 school kids, participated in the community forestry workshop. The objective of the workshop was principally to provide an overview to the community as to the plans for the "Paisajes Sostentables" program that Guyra is directing. Most of the people at the meeting knew about the program generally, and some knew quite a bit, but the idea was to provide an opportunity for everyone to hear about, and not just those who have already been approached because Guyra knows they are progressive (about 5 of the participants turned out to be forestry "promoters". They were exceptionally enthusiastic about what they were doing on their respective farms in terms of agroforestry). There are a number of corporations and foundations working with Guyra, including American Forests, that is donating $70,000 to pay for 70,000 seedlings of native and exotic trees that will be planted as windbreaks and for agroforestry as well. Pajarito is a very big exporter of hierba mate from Paraguay that will provide credit to the productores to buy seedlings of mate, and will enter into contracts with them to require organic farming and will guarantee a market for the mate (the European market has high demand for organic mate and it is worth much more than "normal" mate). The idea is to create some forest cover, using native trees where common, but also to generate a trustworthy source of income for the productores. For its part, Guyra is trying to create a corridor of natural vegetation that begins to link the islands of forest that still exist in the region.

11.4 While the enthusiasm for trees reigned high during this community reunion, there were a couple of issues that emerged. A major concern of many of these farmers was that chemicals which are widely and frequently used to control weeds in the soybean farms being run by multi-national corporations, were often drifting into their much smaller farms and killing some plants and, at least in a few cases, making their kids sick. Glyphosate is one of the chemicals used routinely. It is not known what chemical might have made the kids sick. The big landowners have also not planted any windbreaks to catch the veneno or to reduce erosion, and they have mostly ignored the national laws concerning the maintenance of 25% of the property in forest. The small producers wondered why we were focusing so much on them, when the "real problems were on the large soy farms owned by foreigners". Good question, but one that will have to be resolved within Paraguayan political circles.

Other sites visited, March 11

11.5 At the Bella Vista Agroforestry site we saw pines, *Tabebuia* and Loro Negro planted in lines with about 5 meters spacing and with mate planted between these rows. The pine are actually doing the best of the tree species, but cannot be used in this particular agroforestry configuration because pine needles can get caught in the mate foliage when this is being harvested, and, when this happens, the tereré acquires a bitter taste. The owners of the property are planning on removing the pines over the next 3-5 years.

11.6 Where erosion check dams were built across gullies in open soybean fields, a few of these dams had broken through. Probably the planting of pines into the walls of these check dams, and in a 10 meter wide swath above the check dams, could have made these dams much more resilient as both the root systems, duff and mychorrhizal systems would all combine to bind the soil in place much better.

11.7 Where crops are planted in the well-structured Ultisols of SE Paraguay it is common, according to Gabriel, to fertilize each crop with 300 kg/ha of DAP (Diammonium Phosphate) and to also apply 2,500 kg/ha of crushed limestone every five years. This indicates that fertilization, especially with DAP should also be important for trees that are planted into these soils.

Visits to small farms in the Libertad del Sur area

12.1 Jorge Villalba knows how to grow both pine (*Pinus taeda*) and eucalypt (*Eucalyptus grandis*) well, as both of these species are growing at about 10 and 12 m^3/ha/yr, respectively. No pruning had taken place so far in these stands.

12.2 *Cedrela fissilis* was growing very rapidly, but 100% of the trees of this species have been hit by *Hypsiphylla grandella,* a moth which lays its eggs in tender, new shoots. These produce voracious larvae which eat down through terminal leaders eventually killing them and causing affected trees to develop into a short, squat, multi-sprouting bush, instead of a fast-growing, single-stemmed tree loaded with wood of exceptional value.

12.3 Jorge was doing a commendable job of managing his eucalypt sprouts which had developed on stumps subsequent to harvest operations. He was doing both singling (leaving just the best sprout) and doubling with these sprouts.

12.4 Jorge was well aware of all of the economic nuances that surround mate production in this region. Aside from his mate plantation, Jorge had a very well-developed intercropping system, with different parts of the farm dedicated to different crops and crop mixtures, including corn, manioc, mate, cotton, sesame, oranges, pomelo, and a variety of native and non-native hardwoods, as well as loblolly pine.

12.5 Jorge was enthusiastic about the market for his sesame seed, but this was because he was producing “organic sesame”. The market for normal sesame is not nearly so good right now. In fact, sesame seed prices had dipped to just a

fraction of what they were the previous year and protests had broken out in Asunción (this later resulted in some pretty drastic steps by the federal government to guarantee very high prices for sesame in Paraguay).

12.6 *Peltophorum* and Loro Negro (*Cordia*) were growing very fast on Jorge's farm but they were also open grown which means that, unless correctly pruned, their form will be sub-optimal and they will be producing weak boards with large knots and knotholes. Like many people in the area, Jorge is milling his own lumber with a chainsaw. He has a very steady hand and produces some amazingly clean boards. The Paraiso trees (*Melia azedarach*) were growing well on Jorge's farm, but the market for the wood of this species has collapsed in Paraguay.

12.7 Blas Amarillo has about 4 hectares of oranges and pomelo. His citrus grove has been separated from his neighbors by some rows of *Eucalyptus grandis*. The orange trees have a mild case of cancrosis. Gabriel Sanchez has indicated that if Blas were to plant rows of eucalyptus trees between all of his rows of oranges that this would cut down on the "cancrosis". We (Nick Rogers, Ximena Silva and Phil Cannon), spent about 45 minutes laying out a possible experiment to test this theory and to also determine the impact of so many eucalypt trees on orange production. (Refer to the section on cancrosis in the recommendations section). (Important Note: Since returning from this trip, Phil has exchanged multiple emails with Dr. Alberto Gochez of INTA in Corrientes, Argentina. Alberto confirms that cutting down on wind speed through use of wind breaks is absolutely critical to reducing the amount of leaf damage and subsequent cancrosis development. However, his windbreak-spacing recommendations are not nearly so tight. Accordingly, the recommendations for these spacing have been modified).

12.8 Eugenio Perez has an excellent farm layout for both experimentation and demonstration of different agroforestry systems. It includes the following:

a) windbreaks of eucalypts to delimit property lines;
b) woodlots of eucalypts
c) a widely spaced (between rows) orange grove that has variously ordered rows of mandioca (cassava), corn and beans. (Note: this is a form of alley cropping).
d) Rows of alternating lapacho (*Tabebuia*) and Paraiso
e) Rows of *Grevillia robusta*
f) Lots of shade trees, particularly around the house
g) And about ten hectares of natural forest that Eugenio badly wants to manage.

12.9 The fact that Eugenio is trying alley cropping and with so many different combinations of different crops in the alley ways would make this a perfect farm to do some economic research to determine the best alley cropping system for this area.

12.10 Eugenio's farm is on a steeper slope than the other producers we visited, which results in better drainage. His manioc plants were some of the healthiest and fastest growing we had ever seen. Eugenio's farm also includes a couple of blocks of "intact" forest that he would like to plant with some of the more valuable hardwood species so as to provide some income from those parts of his property.

Peace Corps agroforestry support

12.11 In Libertad Del Sur, Nick Roger's agroforestry library looks like it is off to a real good start. It is very tidy and user friendly. He could use some more appropriate literature and posters for this library. Nick's nursery is coming along, but he could certainly use some additional materials and a better soil mix if he is going to ramp up the productivity of the nursery. The school kids seem real interested in this project.

Visit to PROCOSARA (Asociación Pro-Cordillera San Rafael) headquarters

12.12 PROCOSARA is an important local ally for GP in the Reserva San Rafael area. PROCOSARA was founded in 1997 by local residents and farmers who were alarmed at the rapid deforestation of southeastern Paraguay. The organization is dedicated to the conservation of the forest within the Reserva San Rafael, and they focus on forest monitoring, purchasing forest property, and developing sustainable land use practices in the surrounding areas. We visited their HQ, which is on the southeastern boundary of the Reserva, and is co-located with an organic soy farm. The site has a number of nature trails, one of which we visited with a guarda-parque. The trail is well marked and includes many placards giving the common and scientific names of tree species. They also had two full-time assistants running a nature education center and they spoke of having a fairly large nursery which we did not have time to visit. PROCOSARA has agreed to produce and plant 50,000 tree seedlings from this nursery for reforestation efforts in the Libertad del Sur area.

Kanguery forest, Jacu-poi trail

13.1 The 3.5 km trail (the "Jacu-poi" trail) that enters the forested area behind the Puesto Administrativo at Kanguery has many interesting things to see, including a long list of trees, lianas, shrubs, animals, birds, insects, pathogens and more. Some trees are identified by signs, and this could be expanded.

13.2 It is obvious that the forest area accessed by the trail had been heavily logged and subjected to extensive (within forest) grazing in the past. Some large pieces of ground may also have been cleared for grazing, where this happened, the forest did not grow back. Where the forest was not cleared, but where occasional logging and grazing took place, the forest is growing back quite well.

13.3 For the most part only native species have come back into the openings made in the natural forest. However, *Hovenia dulcis* can also be found occasionally and

this tree demonstrates an amazing capacity to invade. In one spot where one *Hovenia* individual began to grow about 8 years ago, there are now about 20 saplings and another 200 seedlings. Daniel talked about GP plans to try to remove the *Hovenia* individuals from the forest.

13.4 There is a cleared area of approximately 8 hectares at the far end of the Jacu-poi trail where GP has tried to replant a set of about a dozen native trees in a grid format. We spent almost 2 hours here assessing seeding survival and growth. Survival has been mediocre, and individual tree growth poor. We found 50% survival, and only 22% of surviving seedlings had grown since planting. See Appendix 4 for details.

13.5 A soil pit at this site revealed that the soil is comprised principally of a uniformly fine sand down to at least 70 cm. There are only a few mm of soil with significant organic matter and this is right at the soil surface.

13.6 Daniel showed us a large tree about 20 meters off of the main Jacu-poi trail where a natural cavity in the trunk has allowed access into the canopy via a board and wire ladder. GP has built a small temporary platform about 15 meters off the ground. The idea is to allow trail users to access the tree canopy from here. They may remove a couple of the neighboring trees to allow better visibility into the surrounding forest.

13.7 Soil pits dug in the grassland and in the adjacent forest at Kanguery (the Puesto Administrativo) show that the soil type is the same under the two vegetation types (alluvial sand parent material, with a laterite below), although soils in the grasslands may be somewhat shallower (less B horizon) than in the forest (we did not get enough replication to determine this with any real certainty). It appears to us that site history has a lot to do with the forest-grassland boundary here, i.e. grazing and fire history. A recent fire in the grassland killed tree seedlings and saplings that were emanating from the forest. This site is an upland site, with minor potential for soil water-logging.

Guyrareta reforestation project

13.8 Soil pits at the Guyrareta site indicate that these soils consist of a very deep fine sand. The area is characterized by hummocky topography, with areas that are clearly seasonally saturated with water. Soils were dry near the surface but by 30 cm of depth there was perceptibly more soil moisture, and by 80 cm depth one could almost squeeze water from the soil. The A horizon on this profile was only a few mm deep.

Nursery conditions in the Libertad del Sur project area

13.9 Seedlings that did not get planted during the last rainy season and that are now being held in the flying nursery in the “La Amistad” community are mostly in bad condition. At least 70% of these seedlings are “passed”, i.e. they have passed their suitability for planting and should be destroyed and not planted. The

soil matrix is a brick-like sand which does not allow roots to develop within the matrix and which does not have any organic matter in it. This soil will not hold water well and will fall off of the root-ball if the bag is removed (which is probably why seedlings were planted with their bags on in the first planting at Guyrareta).

14.1 The seedlings in the flying nursery at the Puesto Administrativo are in the same condition as those found at 'La Amistad" (see 13.9), i.e., most of the seedlings are passed and basic techniques for successful nursery management need to be undertakem.

14.2 A soil sample was collected for the purposes of getting a chemical analysis of at least one of the soils in the area. This sample was formed from a composite of soil samples collected from 2 to 10 cm depth from 15 different locations in the field that lies between camp and the trail entrance into the forest behind Kanguery. The zig-zag technique was used for deciding on the 15 different locations. Note: this sample was given to Dr. Martin Quinteros who agreed to get it analyzed at the soils lab at the National University.

14.3 The Caronay nursery looks like it may be run well at times, but at this time there were lots of "passed" seedlings, the beds were uneven and the soil matrix did not have any organic matter in it. The germination bed was also uneven. On the other hand, the nursery was doing a good job of screening the main soil component (a well-aggregated Ultisol) and there was overhead sprinkling. This nursery could be put right with a few improvements.

Asunción workshop: "Experiences with forest plantations in rural communities in Latin America"

17.1 See Appendix 3 for the Program of presentations

17.2 About 75 people attended the first day of the workshop, which was held in the auditorium of the library of the Facultad de Ciencias Agrarias. The first day was devoted primarily to agroforestry.

17.3 The presentation by Martin Quinteros from the National University made it clear that foresters have a relatively good handle on growth characteristics and propagation of commercially-valuable tree species in Paraguay.

17.4 Lisa Monges' presentation covered an agroforestry project east of Asunción where she and her students carried out monitoring of social and economic indicators. This was heartening, as we had seen no evidence to that point that socio-economic concerns were receiving much attention in agroforestry in Paraguay. It is very important that the skills and techniques that Lisa and her collaborators employed in this project also be extended to the Libertad del Sur project.

17.5 After the workshop, Cannon led a mini-workshop on designing field experiments in agroforestry. There were about 25 students present. They all appeared to have a basic background in statistics and experimental design.

18.1 About 100 people attended the second day of the workshop. The higher attendance was due to a couple of university courses which assigned the workshop as coursework. The second day was devoted primarily to monitoring and fire management, with a short presentation on landscape-level issues related to forest cover and corridors in the San Rafael area. Presentations by Larissa Rejalaga (about fire management in the San Pedro area in 2007) and Oscar Rodas (about native species plantations and their integration into forest corridors) were cancelled.

Notes from March 18 visit to National University

18.1 The reference for a good survey on soils in the eastern part of Paraguay was obtained from some soils students at the National University.

18.2 A 10 minute conversation with Dr. Hector Causarano was satisfying, if short. Hector had just returned from a six year post-doc in Maryland. During this period he had been modeling drainage systems in agricultural fields in Iowa and Kansas. We discussed some (but certainly not all) drainage opportunities in Paraguay.

18.3 The conversation with Aida Orrego Fuente, Professor of Forest Pathology at the National University, indicated that there were several forest pathology problems in Paraguay. These include the following:

> *Diaporthe cubensis*, the canker causing pathogen of Eucalyptus grandis and several of its hybrids.
> *Puccinia psidii*, which is causing problems in *Eucalyptus grandis*.
> *Mycosphaerella* spp……causing a leaf spot on Tabebuya (Lapacho)
> A Phytoplasma which is causing vascular problems in Paraiso
> A *Guignardia spp.,* which is causing leaf-spot problems on a couple of species.
> *Xanthomonas citri*, which is causing a shot-hole effect in orange tree leaves.

18.4 A student, Christian Grabowski, is about to go to the University of Viçosa, Brazil to study rust (*Puccinia psidii*) with Professor Reginaldo da Silva. (Note: This will give us the bridge we need to get Paraguayan strains of this rust sent up to Acelino Alfenas and his team so that their molecular genetics can be studied, this is another project that Phil Cannon has been involved with, with support from the IAT and the IP).

18.5 The nursery at the National University is in very good shape (the soil matrix is a great mix, the beds are level, seedling development is very homogeneous and fast for all seedlings of the same batch, there are few empty bags, no serious pests

or pathogens, etc). On the basis of these indicators this nursery could serve well as a model to other nurseries in the country that might want to raise some of these same species. There were about 20 species in this nursery at the time of this visit.

18.6 An important reference was browsed in the National University Library, it is as follows:

> Oscar Lopez Gorostiaga and seven other authors. 1993. *Estudio de reconocimiento de Suelos y de Capacidad de uso de la tierra de la region Oriental del Paraguay.* This work was supported by the Paraguayan Minister of Agriculture and the World Bank, but was actually financed by the Government of Japan. In this reference, two soils in Southern Paraguay received a great deal of attention. One was the red Ultisols, which have good internal drainage and low native fertility (which can be amended by applying limestone, zinc and NPK every six months). These are the soils that are found over much of the area that is to the south and east of the San Rafael Reserve Area.
>
> The other was the Abaquults which predominate over a vast extent of the Southwestern portion of Paraguay (Generally the whole part of Paraguay that could be found within a triangle made by using the Paraguay and the Parana Rivers as two side of the triangle and a line drawn between Asuncion and Encarnacion as the third line). These soils are of alluvial origin, usually have a sandy texture, and have a high water table and very scarce potential for agriculture. These are the soils that are found in the Guyrareta part of the Reserve, where the two large native-species plantations have been attempted.
>
> Many of the soils in the reserve itself also would appear to fall into the category of Abaquults and this may well be the reason that there has been relatively little pressure on the land in the reserve to convert it to farming or any other land-use. On the other hand, there are also some variations. At La Amistad, (the Gambia-shaped Guarani community) which sticks right into the middle of the reserve, the soils are again bright red which makes these soils adequate for farming and other uses. Also in some of the profiles dug into the natural prairies, at the higher elevations in the reserve, it is also common to find that there is a sandy horizon overlying a bright red, and very hard, substratum (probably laterite or plinthite).

APPENDIX 3: Program for workshop*"Experiences with forest plantations in rural communities in Latin America"* at the Universidad Nacional de Asunción, March 17-18

Programa

Día Martes 17 de Marzo

0800-0845	Palabras de Apertura USAID, Fernando Balsevich Guyra Paraguay, Alberto Yanosky Decano de la FCA, Lorenzo Meza US Forest Service, Hugh Safford
0845-0915	Experiencias en Paraguay de plantaciones de especies nativas: Martin Quinteros (UNA)
0915-1000	Tecnicas de plantación e irrigación: como mejorar los resultados de plantaciones: Philip Cannon (USFS)
1000-1030	Proyecto en comunidad campesina: Elizabeth Monges (UNA)
1030-1110	Experiencias en América Central y Perú en proyectos de reforestación con comunidades campesinas: Philip Cannon (USFS)
1110-1130	Receso
1130-1200	Experiencia de proyectos MDL F/R JIRCAS/INFONA: Jorge Ogasawara
1400	Como diseñar experimentos forestales: Philip Cannon (USFS)

Día Miercoles 18 de Marzo

0830-0910	Protocolos de monitoreo: experiencias en Latinoamerica: Hugh Safford (USFS)
0910-0940	Aproximacion de paisaje para integrar en las plantaciones de especies nativas: Ximena Silva (Guyra Paraguay) y Hugh Safford (USFS)
0940-1010	Experiencia de manejo de incendios en San Pedro: Larissa Rejalaga (UNA)
1010-1030	Receso
1030-1100	Manejo de fuegos: casos en Latinoamerica: Hugh Safford (USFS)

1100-1130	Importancia de monitoreo biológico en restauración: Leticia Lopez (Guyra Paraguay)
1130-1230	Conclusiones: Líneas de trabajo en conjunto: todos

APPENDIX 4: Survival and Growth of Native Tree Species planted within the Reserva San Rafael, at (1) the forest restoration area along the Jacu-poi trail at Kanguery, and (2) Guyrareta.

APPENDIX 5: pdfs of Safford presentations given at the Agroforestry workshop at the Universidad Nacional de Asunción, March 18, 2009 (electronic files attached)

APPENDIX 6: Specific recommendations for nursery and seedling-propagation management

It should be realized that at the time of our trip to Paraguay, none of the nurseries that we visited were operating in top form, as the timing of our visit was about 4 months after the last seedlings were planted for 2008 and before the commencement of of seed sowing activities for 2009. Nevertheless, from the 5 nurseries that we visited in the Libertad del Sur Area (we did not see the PROCOSARA nursery), it was apparent that improvements could be made that would favor the development of better seedlings. Here is a list of suggestions:

- Do not plant "passed" seedlings (these are old seedlings that were not planted when they were supposed to be planted); throw them away. In one of the major nurseries and in the two flying nurseries at La Amistad and Kanguery (Puesto Administrativo), many thousands of passed seedlings were being cared for and we were told that they would be outplanted during the next rainy season. This would be very unfortunate, as these seedlings have shoots that are much larger (5 to 10 times) larger than their corresponding root systems and the planting of these trees can only end in failure. Most will die within a few months of planting and the few that survive will be vulnerable to windthrow and/or auto-strangulation as their roots are invariably poorly formed and often spiral around within the confines of their polyethelene bags.
- Put a few holes in the bottom of polyethelene bags so they can drain water. Most bags we inspected had such holes, but some did not.
- Use a potting mix that has better moisture release and "binding" properties (i.e. the soil will hold together better) than the soil that is currently being used. This can be accomplished by adding organic amendments to the soil.
- Make the base of the container bed as level as possible; we saw some instances where the undulating nursery bed was having obvious effects on seedling health.
- The cement (10 cm x 30 cm x 40 cm) germination trays looked perfect for their purpose, but the surface of the sandy-textured soil in these trays should be level in order to ensure homogeneous and excellent germination.

- Transplant seedlings from the germination beds to the polyethelene containers 12 to 20 weeks before the seedlings will be planted in the field. The fastest growing species (e.g., eucalypts and some of the legumes) need about three months in the nursery, the slower ones often need another month or two. In the polyethelene bags that were being used by Guyra (approximately 10 cm x 18 cm in size) the optimal seedling should be about 25 to 30 cm tall at the time it is outplanted and it should have a root system that is well-branched and that completely fills the soil matrix in the bag (but has not yet started to bend at the bottom of the bag or to coil around on the inside of the sides of the bag). Planted seedlings should have a shoot to root ratio of 1.0 to 1.0, or 1.5 to 1.0.
- Do not water too much initially to avoid "damping-off" (a fungal infection), but once the seedlings are well-established, they can be watered with frequent short sprinklings.
- About one month before outplanting, start cutting back progressively on the watering, with the purpose of "hardening" the seedling so it will be more able to withstand the shock of being transported to the site and then planted.
- Prune the roots as they approach the bottom of the polyethelene bags. There are two practical ways of doing this. Put a level layer of gravel on the nursery bed and then place the bags on top of these or, after the seedling are two months old, move them individually about once every two weeks until it is time to plant. This movement will kill the root tips and stimulate root branching.
- If seedlings grow slowly or irregularly, fertilizer can be tried, usually somewhere between ½ to 1 gram of NPK 10-30-10 per seedling over the full stay in the nursery will produce a very nice response. The best way to do this is during irrigation: thoroughly mix about 50 gms of NPK with about 20 liters of water and then apply this mixture with a watering can, watering all seedlings until they are wet, but not soaked. Follow this immediately with a second watering but this time using just water; this is to wash fertilizer residue off of the leaves and into the soil. Apply fertilizer in this manner at 4, 6 and 8 weeks after transplanting and then stop applying fertilizer so that the seedling can slow down its growth and become "hardened" in time for outplanting.
- Transport seedlings carefully, making sure not to pile seedlings on top of one another and protect them from the wind and sun during transport.
- Plant seedlings after there has been about one week of good rain, preferably at the beginning of the rainy season.
- Be sure to remove the polyethelene bag at the time of planting.

We think that it would be important to do a thorough nursery review when these nurseries are operating at full-tilt (i.e. during the pre-planting season). This could be done with nursery experts that are already in Paraguay. The people operating the National University nursery in Asuncion are clearly experts in nursery and seedling management, and we recommend that they be contacted to provide consultancy to the LDS area nurseries. The National University nursery will probably also have information on where to get the best and most cost-effective indigenous nursery materials as well.

APPENDIX 7: Specific notes and recommendations on tree planting

Replanting at the Guyrareta site (and other similar sites)
Many of the tree planting projects that were done inside the reserve have not done very well. Reforestation always has very variable success, but one typically hopes for at least 50% survival. The sites at Guyrareta were far below this. The soil pits and the literature indicate that poor internal drainage, a widely fluctuating water table, a very sandy texture and almost no A horizon or organic matter make this a pretty hostile environment for most tree species to get started in. On the other hand, once trees do manage to get established, they can often draw down the water table to a significant degree and thereby maintain an effective rooting zone sufficient in volume to support decent tree growth.

In areas like Guyrareta, where there has been very poor establishment to date and conditions are somewhat hostile, the management decision comes down to either giving up on trying to plant these lands (i.e. allowing for natural regeneration), or trying a different approach for getting seedlings established.

If planting is desired at Guyrareta, we recommend that a simple mapping exercise be carried out, to identify those places that are under water at peak flood stage. This mapping exercise, to be most successful, should be carried out in the middle of the rainy season when the flood waters are at their absolute highest. Areas falling below the high water table simply should not be planted. These areas are natural grasslands and should be left as such.

In the higher areas above the high water table, one or two of the following activities, all aimed at improving internal soil drainage, are also recommended for consideration:

> Use a shovel to build a small mound of soil (approximately 40 cm high)
>
> Use a backhoe with a long reach to make many small mounds of soil of the same height. If the Scottish model is followed, a nice network of drains can also be built in the ditches where the soil is being scooped from.
>
> Use a tractor with reverse-facing disks to pull berms spaced at about 4 meters between centers and oriented perpendicular to the slope to promote drainage of water and cold air.
>
> These site prep methods may seem slightly complex, but they are actually fairly straightforward and there are millions of hectares of similar ground being planted each year where one of these forms of mounding is employed (e.g. Florida, Georgia, Louisiana, Minnesota, Scotland) and at costs which are not cheap, but not a project killer either (ca. $100/ha)

Here are further recommendations that will contribute to better seedling survival and growth:

Use herbicides (e.g. glyphosate) to keep grasses (e.g., *Bracchiaria*) from competing with the young seedlings.

Incorporate organic matter (1 kg per planting spot) into the mound at the planting spot. This will help keep the mound from "melting" and will tremendously increase the amount of water that these soils will be able to deliver to the young seedlings.

Be sure to wait about two weeks after doing physical site prep work (or until after a rain) before planting. This will help ensure that the soil has settled and that large air spaces in the soil have had a chance to collapse.

Just prior to planting, make a hole large enough to accommodate the seedling near the top of the mound. The soil should still be soft enough that this can easily be done by hand.

Remove the seedling entirely from the container (usually a plastic bag) and plant so that the root collar for the seedling is level with the top of the soil. Compact the soil firmly (but not excessively) around the seedling at the time of planting.

Use a mulch within a 30 cm radius of the planting spot to ensure that the moisture in the top 5 cm of soil is not rapidly evaporated by the sun. This is particularly important for seedlings planted near the end of the wet season.

Fertilizer recommendations:

It will be wise to wait until the results of the soil chemical tests are back from the National University (Martin Quinteros) before keying in on the exact dosages, but certain chemical deficiencies should be anticipated. It may actually be a little tricky to apply fertilizers to these soils. The Cation Exchange Capacity (CEC) of a "sandy" soil is very low, so if a heavy dose (e.g. 50 grams of Diammonium Phosphate [DAP] or 75 grams of NPK 10-30-10, which are the recommended dosages of these fertilizers on many soils) were to be applied to a single seedling planted in these sands, then that seedling would be at risk of dying from the drought stress imposed by the salty nature of the fertilizer. For this reason a relatively low initial dose of one of these fertilizers (say about 20 gm/seedling of DAP or 30 gm of NPK) should be used, and a space of about 20 cm should be left between the point where the fertilizer is applied and where the seedling is planted. The fertilizer should be incorporated into the soil slightly using a hoe so as to reduce volatilization of the nitrogen component of the fertilizers. It is also advisable to apply 3 gm of borax and 2 gm of zinc to each seedling. Boron is likely to be deficient in these soils because (1) they are sandy and boron leaches very quickly through sand, and (2) the usual source of boron is from atmospheric deposition from clouds that have originated over the ocean, and Paraguay is a long way from the coast! To solve the leaching problem, it is advisable to begin by applying boron and zinc chelate (where these trace elements are sprayed onto a

glass pane which is subsequently shattered). This is a slightly more expensive delivery mechanism for these chemicals, but it can deliver a big response.

Note, since most of the plants that will get planted at Guyrareta are likely to be Legumes, it will also be important to apply pulverized limestone on the surface of the planting site (about 500 gm/plant) and to also apply some sulfomag (the magnesium is needed for the leg-hemoglobin which helps the rhizobial symbionts be much more effective at becoming established in the roots systems and of fixing nitrogen for the seedlings).

It should be realized that since the initial dosages of N, P and B are small, it may well be very important to come back in 6 months to a year and apply two to four time this level of chemicals for each plant (depending on how big they have become over this period).

Seedlings should usually be planted one to two weeks after the beginning of the major rains. There should usually be no need to apply water. However, in Paraguay rains have been rather unpredictable lately. If it happens that the rains slow down or stop after planting, it is advisable to apply water to each seedling, especially is they are in sandy soils. To do this, a small depression is made 20 cm from the seedling and then 2 to 4 liters of water is added per plant. A one-time application in the life of the tree should usually suffice.

We recommend that a policy of experimentation be adapted for the first year or two until the best and most efficient combination of tree establishment techniques are settled on. Then the remainder of the area can be planted with this “appropriate” technique.

We recommend that the forestry group from Guyra Paraguay travel to Missiones or Corrientes in Argentina, where there has been a history of trying to establish plantations on quite similar soils. It is very likely that they have developed a number of measures for helping get plantations established on sandy, water-saturated ground (or they have simply backed away from planting these types of sites wherever they can be identified).

If the decision is made to go ahead with planting at Guyrareta (and other saturated, sandy sites), besides implementing the site preparation recommendations (above), there are a few other practices that we also recommended:

Seedling quality must be much higher than the seedlings that we observed at the flying nurseries in La Amistad and at Kanguery at the Puesto Administrativo. Those seedlings, because they were held over for an additional four months, currently have a +/- 10 to 1 ratio of shoot biomass to root biomass. The optimum ratio of shoot to root biomass is 1 to 1. Also, roots did not form well in the soil of the plastic containers. Specifically, there are few roots in the soil matrix itself, there are many seedlings with “J-shaped” roots (where one or two big roots come out of the bottom of the bag) and many with spiral roots (where roots grow to the interface between the soil in the container and the container wall itself and then

start to grow round and round). J-rooted trees and spiral rooted trees almost always die in the end, although the mortality process may take 5-10 years. The roots will simply fail, or they will actually strangle the tree, or the tree will be blown over in a strong wind, etc.

Another recommendation is that livestock be kept off the site until all trunks are at least ten cm in diameter. Even then, allowing cattle onto the site may lead to basal cambial tissue becoming damaged by cattle hoofs. This can lead to basidiomycete infection that will kill the trees through bole rot.

Another important recommendation is that if this area gets planted again, serious fire prevention measures must be set into play. One good possible first step, especially if a tractor were to be brought in to help with the soil mounding for planting, is that the entire planted area be ringed with a 10 m fire break. 10 meters should be seen as a minimum width. This area must be kept more or less grass-free for many, many years. Herbicide, prescribed fire, or grading can be used to keep this area fuel-free.

Replanting in the Restoration Area at Kanguery

In the Kanguery site, the survival rates were substantially better than at Guyrareta, although still not optimal, and growth was in general quite disappointing.

There is not a need to conduct nearly as many site preparation activities at the Kanguery site as at Guyrareta, principally because there is much better drainage here. Still, it is important to use optimally-sized seedlings (1:1 shoot to root ratio). We saw much tip dieback on the surviving seedlings at Kanguery, and this could be reduced by planting only healthy seedlings. A small soil mound (30 cm) might be worth trying for the seedling planting spots, and we also recommend the use of a mulch.

At the Kanguery site we found that at least 10% of the seedlings had been dug up by armadillos. The armadillos were probably just looking for a soft place in the ground to dig their holes, and planting spots are very soft! Perhaps there is some kind of mulch that could be applied to the area around the base of a seedling that would make it a disagreeable place for armadillos to dig(?). Perhaps an old nursery shade cloth (e.g. Seram 60% shade) could be cut into 80 cm x 80 cm patches that could be placed at the based of the seedling during planting. Probably some experimentation should be carried out, with the aim of finding something that both aids seedling survival and keeps armadillos out. We recommend that the GP staff at Kanguery (e.g. Ramon and Daniel) be asked to think about this. They are full of clever ideas.

From the plantings that were already done, it is clear that some tree species have demonstrated a clear superiority in survival and growth. These include Arbol Amarillo, Timbo, *Cedrela*, Rabo, *Peltophorum* and *Inga*. We recommend that these species be favored in the next planting.

Fertilization recommendations: We recommend application of approximately 30 grams of N-P-K to each seedling, split between two holes that are 20 cm distant from the planted seedling, and 3 gms of borax. For all leguminous species, in addition to the above, we recommend application of an additional 10 gms of sulfomag and 100 gm of limestone per seedling.

It will be very important to control competition from other plants. A carefully directed spray of glyphosate (avoiding *any* contact with the planted seedlings) should prevent most of this competition. Where ferns are beginning to become a problem a more vigorous weed control program is called for. There are a few chemicals that can help, but it is important to determine which might be registered for use in Paraguay before making any definitive recommendation.

Planting trees in the agroforestry project (private lands)
The planting areas to the south and the east of the reserve on the small farmer holdings do not represent nearly as many barriers to successful planting as the reserve sites. This is primarily because the red, well-aggregated, ultisol soils which are found throughout the area south and east of the reserve have much better moisture release properties and better nutrient status than the sands in the reserve. Furthermore, the farmers in this area (with and without GP's assistance) have already demonstrated that they are competent at growing about 20 different tree species, and at using these trees species in a number of different spatial arrangements, in combination with multiple food crops in an array of different agroforestry systems.

APPENDIX 8: Specific recommendations on optimization of agroforestry systems in the Libertad del Sur project area

Currently small farmers in the project area are selecting the tree species to plant, the places to plant and the combinations and the spacings of trees to plant, and what crops to plant in between these trees based on the availability of seedlings and their own preferences. There appear to have been very few systematic economic studies conducted in Paraguay to try to determine the absolute best combination of trees and crops. The lone exception that we are aware of is a study conducted by Professor Lisa Monges of the National University, but in a very different part of Paraguay.

We did not learn a lot about Paraguay's capacity to conduct such economic studies, however, it appears that there are economists like Prof. Monges and Marcelo Arévalos, who is a principle member of the GP staff and who is already conducting economic studies in the project area (on organic sesame), that may be available to conduct these studies.

We recommend that GP and the Forestry Faculty at the University become familiar with the large body of economic studies that have been conducted on agroforestry systems in Central America at CATIE over the past 15 years. Although some of the tree and crop species may be slightly different, many of the general agroforestry systems that have been developed and tested at CATIE will have application in Paraguay as well. In

addition, the general methodology for designing and monitoring agroforestry systems used at CATIE and elsewhere can be adopted in Paraguay. Phil Cannon will be glad to set up an exchange with CATIE if this is desirable. Masters degrees for Paraguayans at CATIE (or at the U. of Florida in P.K. Nair's program) should also be considered as a possibility.

One of the things that will almost certainly be exposed when economic studies of agroforestry systems are run in Paraguay is that the markets for different woods (species and grades) that are being produced in plantations in Paraguay have, so far only been partially and poorly explored. As a result, most wood that is produced by local producers is only for local consumption and can only generate very low revenues. Again, the way that CATIE (Madeleña Project) researchers (in Turrialba) and the Instituto Technologico de Costa Rica (in Cartago) researchers approached this problem in Central America could provide many valuable lessons.

There are a few other lessons that will probably have to be learned where farmers are growing trees on the red Ultisols. These have to do with the thinning and pruning of these trees as they develop. The absolute best thinning and pruning practices will depend on the type of product that the farmer feels will give him the best economic return. Therefore, until the economic studies (described briefly above) can be completed, we recommend that the following very general guidelines be followed:

> Plant at about 600 to 1000 seedlings per hectare (unless planting in rows, in which case plant at about 2.5 m between seedlings) Thin these trees when they have about 15 cm diameter to about 400 to 500 sph.
>
> Prune the bottom log of the tree (the bottom 4 m) if it is a tree that is being grown for saw-timber purposes, pruning the limbs off when the tree has about 12 cm diameter. This may entail pruning when the trees are about 5 meters in height and again when they are about 10 meters in height (never prune more than half-way up the live crown).
>
> Always use a true pruning saw to prune (note: we did not see any of these saws in Paraguay during this visit, and this is something that GP might want provide to the farmers) and always leave a very smooth cut which begins about 2 mm out from the branch crotch, and is angled at about 10 degrees from vertical so that the bottom cut ends up about 4 to 5 mm from the tree bole. This will minimize the amount of damaged cambial tissue, will prevent the accumulation of water in the wound, will greatly shorten the period needed for the pruning scar to heal, and will significantly reduce the potential for any butt rot from getting started. Pruning will also permit the development of much stronger (maybe 4 to 10 times as strong) boards and better-looking boards.

Most of the trees species that we looked at on the Ultisols appeared to be largely free of serious pest or disease problems. Nevertheless, there are a few forest protection tips that we recommend. The most important recommendation is to do everything possible to

ensure that the bases of trees do not get damaged by cattle. This will prevent infection and eventual rot of the tree trunk by basidiomycetes. We also recommend that planting of *Cedrela* be limited or halted altogether, as almost *Cedrela* individuals we inspected (including seedlings in nurseries!) had been attacked by *Hypsiphylla grandella*. Hundreds of scientist years have been invested in trying to resolve this problem (because the wood is so precious), but the only place where there is really good production of these mahoganies is on islands in the Pacific Ocean which are still free of this pest.

APPENDIX 9: Photos

Our group at the farm of Victor Algarin. From left: Oscar Rodas, Guyra Paraguay (on the phone); Andrea von der Ohe, US Forest Service; Phil Cannon, US Forest Service; Nick Rogers, Peace Corps; Ximena Silva, Guyra Paraguay; Hugh Safford, US Forest Service; Leticia Lopez, Guyra Paraguay; Marcelo Arévalos, Guyra Paraguay; Elizabeth Monges, National University of Asunción; Victor.

Kanguery, Guyra Paraguay HQ for its holdings in the Parque Nacional San Rafael. Orientation presentation given by local Guyra staff to group of USFS, Peace Corp, Univ. Nacional de Asunción, and Guyra Paraguay-Asunción staff.

Guyrareta, area of intermixed natural grasslands and areas cleared by man in the Parque Nacional. Group is inspecting tree planting project from 2008. Seedling survival in this area was very low, perhaps 10%.

Cannon explaining the effects of overstory shading on hierba mate growth. This was an area of hierba mate interplanting with overstory pine and native hardwoods, near Bella Vista.

Erosion in a soy field near Alto Verá. Large, often international producers manage very large farms in the area. Very little or no forest cover remains on these properties, and some areas have major erosion, water quality, and pesticide issues.

Jorge Villalba, a small farmer near Caronay, demonstrates how sesame plants are dried and harvested for their seeds. Jorge's farm included intercropped areas of citrus, hierba mate, mandioca, sesame, and windrows of native and exotic hardwoods

Grassland-forest boundary at Kanguery, Parque Nacional San Rafael. Soil pits showed similar soils under the two vegetation types. Reforestation in the grassland is made difficult by the poor soil, competition by dense grasses, and recurring fires.

Cannon and Leticia Lopez (Guyra Paraguay) inspecting the tree nursery in Alto Verá. This nursery is heavily used by Guyra for its reforestation efforts in the area

Workshop for small farmers in Caronay, to provide an outline of Guyra Paraguay's reforestation and agroforestry program. Safford is speaking.

Cannon leading a workshop for Universidad Nacional forestry students on experimental design, Asunción.